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AFPTEF PROJECT NO. 93-P-125

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DTIC QUALITY INSPECTED 2

Defense Ammunition Packaging Council Project J7

Research Gasket Shapes and Materials for  
Sealed Ammunition Containers

AFMC LSO/LOPD  
AIR FORCE PACKAGING TECHNOLOGY AND ENGINEERING FACILITY  
WRIGHT-PATTERSON AFB, OH 45433-5540  
AUGUST 1996

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AFPTEF PROJECT NO. 93-P-125

TITLE: Research Gasket Shapes and Materials for Sealed Ammunition Containers

## ABSTRACT

The Air Force Packaging Engineering and Technology Facility (AFPTEF) was task with Defense Ammunition Packaging Council (DAPC) project J7, the Research of Gasket Shapes and Materials for Sealed Ammunition Containers in October of 1993.

The objective of this project was to investigate new materials and shapes available for use as gaskets in sealed containers. The properties of the new materials had to be evaluated/tested to assure they met or exceeded the properties of current gasket materials. The project also looked at the manufacturing processes of extruding vs. molding. Which process was most economical, better for the specific material and shape, and creates the better product. We also investigated the joint bonding process of using a chemical adhesive and the technique required to achieve a good bond as well as vulcanizing and heat welding. Another aspect of the project was to evaluate the required cross sectional area and hence the compression required to create a sealed container repeatedly with the minimum amount of force.

Accomplishments of the project are the development of a new gasket using a solid polyurethane. The development of a very effective and economical way of bonding corners/joints of silicone gaskets. The leak and compression testing of various shaped cross sectional sized gaskets. The recommended gasket from the test results will enhance container sealing and extend the gasket's life cycle.

Total AFPTEF man-hours associated with this project to date is approximately 694.

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### PUBLICATION DATE:

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## **INTRODUCTION:**

### BACKGROUND:

The Office of the Secretary of Defense (OSD) established the Defense Ammunition Packaging Council (DAPC) to investigate ammunition packaging requirements and perform some basic research and development in an effort to solve some of the problems identified for ammunition. PM-AMMOLOG, Picatinny Arsenal NJ is handling the overall program management for OSD. All DOD services are participating. A work package proposal for the research and development of a new gasket(s) for sealed ammunition containers was submitted to the DAPC in September of 1992 for consideration. The work package proposal was accepted and approved as a joint service project, DAPC J7, with the Air Force Packaging Engineering and Technology Facility (AFPTEF) as the lead service organization in October of 1993. The project is coordinated with the US Army Packaging Division, Picatinny Arsenal NJ, the Packaging, Handling, Storage and Transportability Center, Naval Weapons Station Earle NJ, and the US Marine Corps Naval Surface Warfare Center, Crane IN.

### REQUIREMENTS:

AFPTEF feels there is a need to improve and/or replace existing container gaskets. Problems we are seeking to eliminate are gasket degradation due to heat caused adhesion, degradation due to ultra violet exposure, degradation due to packaged items leaking fluids that react with the gasket, poor joint bonding, and questionable reseal ability after repeated use. We will also design and test different shaped and sized gaskets to test for the best compression percentage to create a reliable seal.

## **TECHNICAL APPROACH:**

### MATERIAL:

Industry and Military gasket material studies were read and evaluated. AFPTEF's plan of approach was to find a new material, not necessarily one to replace the present materials but an alternative one. The new material had to meet or exceed the properties of the current most widely used silicone and neoprene. It had to be temperature resistant, (-40°F to +140°F), UV resistant, adhesion resistant, tear resistant, have a low compression set, chemical resistant, readily available, easy to extrude or mold into shapes, and economical in price. The new material(s) will be tested to see how well it performs and bonds.

### SHAPES:

The limited shapes of gaskets available, problems with the ones currently used, and the present gasket fabrication technology led to the conclusion that container seal ability, gasket fit, compression, and corner seal problems could be enhanced/solved with gaskets of various shapes. Gaskets can be fabricated to fit any extrusion shape. AFPTEF designed various cross sectional

shaped gaskets, had them fabricated, and tested them to see if gasket shape can enhance sealing.

#### FABRICATION:

Gasket fabrication techniques were investigated to see which process, extruding or molding, was more economical, best for particular materials, best for specific durometers, and best for certain shapes. Gaskets fabricated by extruding and molding was tested and economically evaluated.

#### BONDING:

The quality and performance of gasket joint bonds is determined by the gasket material, type of adhesive, and bonding techniques or method used. Methods of bonding investigated and/or tested were chemical adhesion, chemical adhesion with heat, and heat welding.

#### SEALING:

The old rule of thumb concerning ideal compression of 30% was tested by acquiring gaskets with varying cross sectional areas. We feel this is necessary to verify the 30% compression theory confusion of height compression vs. area compression.

#### **RESULTS:**

##### MATERIAL:

The study results reinforced the good to excellent properties of materials the military presently uses. The most commonly used materials for sealed container gaskets are silicone and neoprene. The new material chosen for evaluation, fabrication, and testing was a solid polyurethane. The 60 durometer polyurethane gasket failed a pressure leak test drastically on the corners of the container. The harder durometer did not allow the gasket to be compressed enough to compensate for the imperfections of the sealing surface. The molded polyurethane gasket compressed beyond use, was sticky, and was easily damaged. In addition it was very difficult to spec out the polyurethane material. Each manufacture patents their processes of plasticizer additive mixtures used in the material manufacturing. Also the properties, such as compression set, aging, heat resistance, are far different than those of your typical gasket materials. See Appendix A for detailed information on the polyurethane material and material specifications.

##### SHAPES:

The most commonly used gaskets in the military are either round or flat in cross sectional shape. Container designs typically provide a groove for round gaskets to lie in and sometimes are provided for flat gaskets. This groove provides gasket side restraint eliminating any tendency for the gasket to roll and in turn creates a good sealing surface area. However, the container corners, due to fabrication requirements, do not provide a groove and therefore, do not provide any side restraint. This lack of

side restraint allows the gasket to roll creating a vulnerable area for sealing and sealing repeatability. Flat gaskets, ones that are rectangular or square in cross sectional shape, typically get bonded into place. Flat gaskets are prone to receiving damage do to their physical shape and location and typically don't provide sufficient compression/seal ability for larger containers. AFPTEF has found that by combining features of the flat and round gasket designs, a gasket that is more reliable in seal repeatability and functionality can be obtained. It has been determined that designing/fabricating a gasket with 90° corners, creates a sufficient sealing surface for the corners for a repeatedly sealed container. AFPTEF designed two shapes for polyurethane material fabrication, one for extruding and one for molding and eight different shapes for silicone material extruding. See Appendix B for shape drawings and Appendix C for test results.

#### FABRICATION:

Gasket fabrication techniques were investigated by speaking to and visiting gasket manufacturers. Most materials used to make gaskets can either be extruded or molded, however the processes may effect the properties of the materials differently. The molding process limits the shapes the gasket can be designed to, due to mold restrictions. The extrusion process is generally much more economical than the molding process and the molding process can only be used for gaskets of smaller size. The technology and costs of the molding process just don't afford larger gaskets. The new polyurethane gasket was extruded and molded. We had the polyurethane gasket extruded first, because it allowed us to place an orifice in the center and do to the fact that it comes in a continuous roll, we could make any size gasket we needed for testing purposes. However, the extruded polyurethane gasket had to be limited to a 60 or higher durometer, the molding process allowed the preferred 30 to 40 durometer but required a shape design change of eliminating the center orifice.

#### BONDING:

The quality and performance of gasket joint bonds is determined by the gasket material, type of adhesive, and bonding techniques or method used. Chemical adhesives are typically used to bond gasket joints in small production runs and prototype and testing situations. A welding or molding process is typically used in larger production runs. A good bond depends on whether the adhesive was properly matched to work with the specific gasket material and whether it was applied correctly. Heat welding or molding requires expensive equipment and therefore is only economical if used in large production runs. Vulcanization, an economical form of heat and adhesive fusion, turned out to be an excellent way to bond joints. The equipment is very inexpensive, easy to operate, and the process takes only minutes form start to finish. Molds can be fabricated to join any cross sectional shaped gasket. It was also found that a small quantity of the raw gasket material, tested only on silicone material, works well

as a bonding agent when using the vulcanization method. We had a very difficult time bonding the polyurethane gasket joints. In speaking with gasket manufacturers it was determined that bonding could be achieved using heat welding or a chemical adhesive. The heat welding process could not be tested since we did not have the equipment. To use a chemical adhesive the elastomer agent used in the manufacturing process of the gasket has to be known to match the correct chemical makeup. Bonding quality was checked by performing pressure leak tests.

#### SEALING:

The old rule of thumb concerning ideal compression of 30% was tested by acquiring gaskets with varying cross sectional areas. The areas ranged from 0% interference at the sealing surface, meaning all of the gasket area can be compressed into either the gasket itself or the gasket groove on the base of the container. To 30% interference which means that 30% of the gasket area will interfere between the base and cover sealing surfaces after full compression. We feel this testing is necessary to verify the 30% compression theory confusion and to see if the gasket is damaged due to the pinching and so forth created with the interference aspect. Pressurized leak tests were performed in accordance with FED-STD-101, Method 5009.3 on each gasket configuration. Keeping track of pressure loss rate and amount of compression required, in inch-pounds, concluded how shape and cross sectional area (% of compression) effected the container seal. For complete results see Appendix C, Test Report.

**CONCLUSIONS:** Using polyurethane as a gasket material, whether extruded or molded, can be considered a viable option. Especially when chemical degradation of the gasket is possible. However, it's properties and uncertainties in material specifications do not warrant use over the present gasket materials of silicone and neoprene. The fabrication processes of extruding and molding have to be evaluated for each type of material, shape, durometer, and usage. Vulcanization of silicone gaskets using a small amount of the raw silicone material is a very effective, reliable, and economical process for gasket joint bonding. Polyurethane gaskets lend themselves to chemical bonding. However, choice of bonding agent is solely dependent on the plasticizer used in the material manufacturing. While all gaskets sealed the container, it was determined that the gasket that performed the best repeatedly was gasket 3, Dwg. No. X9489272 with an area compression of 10% and a latch force of 20 inch-pounds.. Detailed conclusions on how shape and area effect sealing can be seen in Appendix C, Test Report.

**RECOMMENDATION:** AFPTEF will begin using gasket number 3, drawing number X9489272 with a measured the latch force of 20 inch pounds.

## APPENDIX A

1. MOLDED POLYURETHANE GASKET MATERIAL PROPERTIES
2. EXTRUDED POLYURETHANE GASKET MATERIAL PROPERTIES
3. PROPOSED MOLDED POLYURETHANE GASKET ACQUISITION SPECIFICATION



# ***QSC200***

## ***QUASI MDI-POLYESTER PREPOLYMER***

### ***PRELIMINARY DATA SHEET***

#### **FORMULATION**

POLYESTER POLYOL BLEND, PPH	
1,4 BDO, PPH	
TOTAL CURATIVE, PPH	416
CATALYST LEVEL, DROPS	

#### **PROCESSING CONDITIONS**

POT LIFE, MINUTES	6
DEMOLD TIME, MINUTES	90

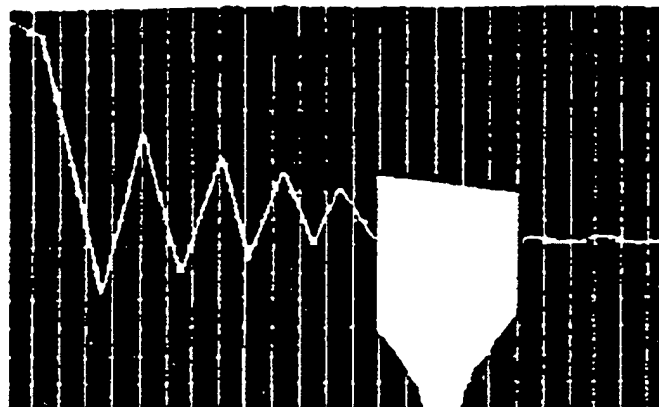
#### **ELASTOMER PROPERTIES**

HARDNESS (A)	45
MODULUS (PSI)	
10% ELONGATION	40
100% ELONGATION	120
200% ELONGATION	170
300% ELONGATION	200
TENSILE STRENGTH (PSI)	1860
ELONGATION (%)	900
TEAR RESISTANCE (PLI)	
DIE C	150
NICK	30
COMPRESSION SET (%)	6
REBOUND (%)	45
ABRASION LOSS (MM <sup>3</sup> )	32
COLD HARDNESS (SHORE A @ -5°C)	47
HOT HARDNESS (SHORE A @ +80°C)	45
SPECIFIC GRAVITY @ 20°C	1.19

EXTRUDED POLYURETHANE GASKET MATERIAL SPECS

FROM: JEFF BELL, TECHNICAL DIRECTOR

SUBJECT: C60A-10WN (TPU)



Jan. 28, 1993

HARDNESS , DUROMETER  
TENSILE STRENGTH, P.S.I. MIN.  
ELONGATION , % MIN.  
GRAVE TEAR (DIE C ) P.P.I. MIN.

60 ± 5  
2600  
750  
250

COMPRESSION SET:

22 HRS. @ 158 ° F  
22 HRS. @ R.T.

40  
20

OIL IMMERSION: ASTM # 3 OIL  
CONDITIONED 20 HRS. @ 212 ° F  
7 DAYS @ 176 ° F


HARDNESS CHANGE , PTS.  
TENSILE CHANGE , %  
ELONGATION CHANGE , %  
WEIGHT CHANGE , %

+ 6  
+ 23  
- 6  
- 24

FUEL IMMERSION: FUEL A  
CONDITIONED 20 HRS. @ 212 ° F  
7 DAYS @ R.T.

HARDNESS CHANGE , PTS.  
TENSILE CHANGE , %  
ELONGATION CHANGE , %  
WEIGHT CHANGE , %

+ 15  
+ 14  
+ 5  
- 27

  
Jeff Bell  
TECHNICAL DIRECTOR

**AGED PROPERTIES**  
**C80A-10WN IMMERSSED IN FUEL "A"**

**Originals**

Hardness "A", pts	83
Ultimate Tensile, psi	2839
300% Modulus, psi	898
100% Modulus, psi	381
Ultimate Elongation, %	930

	<b><u>1 Day</u></b>		<b><u>3 Day</u></b>		<b><u>7 Day</u></b>	
	<b><u>C80A</u></b>	<b><u>% Chng</u></b>	<b><u>C80A</u></b>	<b><u>% Chng</u></b>	<b><u>C80A</u></b>	<b><u>% Chng</u></b>
Hardness "A", pts	70	+10	72	+13	74	+18
Ultimate Tensile, psi	3154	+10	3239	+12	3284	+14
300% Modulus, psi	724	+4	729	+5	718	+3
100% Modulus, psi	380	+5	387	+7	379	+5
Ultimate Elongation, %	988	+4	981	+5	982	+5
Weight Change, %	--	-10	--	-19	--	-27

- All test plaques conditioned for 20 hrs. @ 100° C prior to testing
- All materials were molded & tested in Wyandotte:
  - \*Effects of Liquids: ASTM D-471
- ASTM Fuel "A" = 100% Iso Octane @ R.T.

**AGED PROPERTIES**  
**C80A-10WN**

**Oil Immersions**

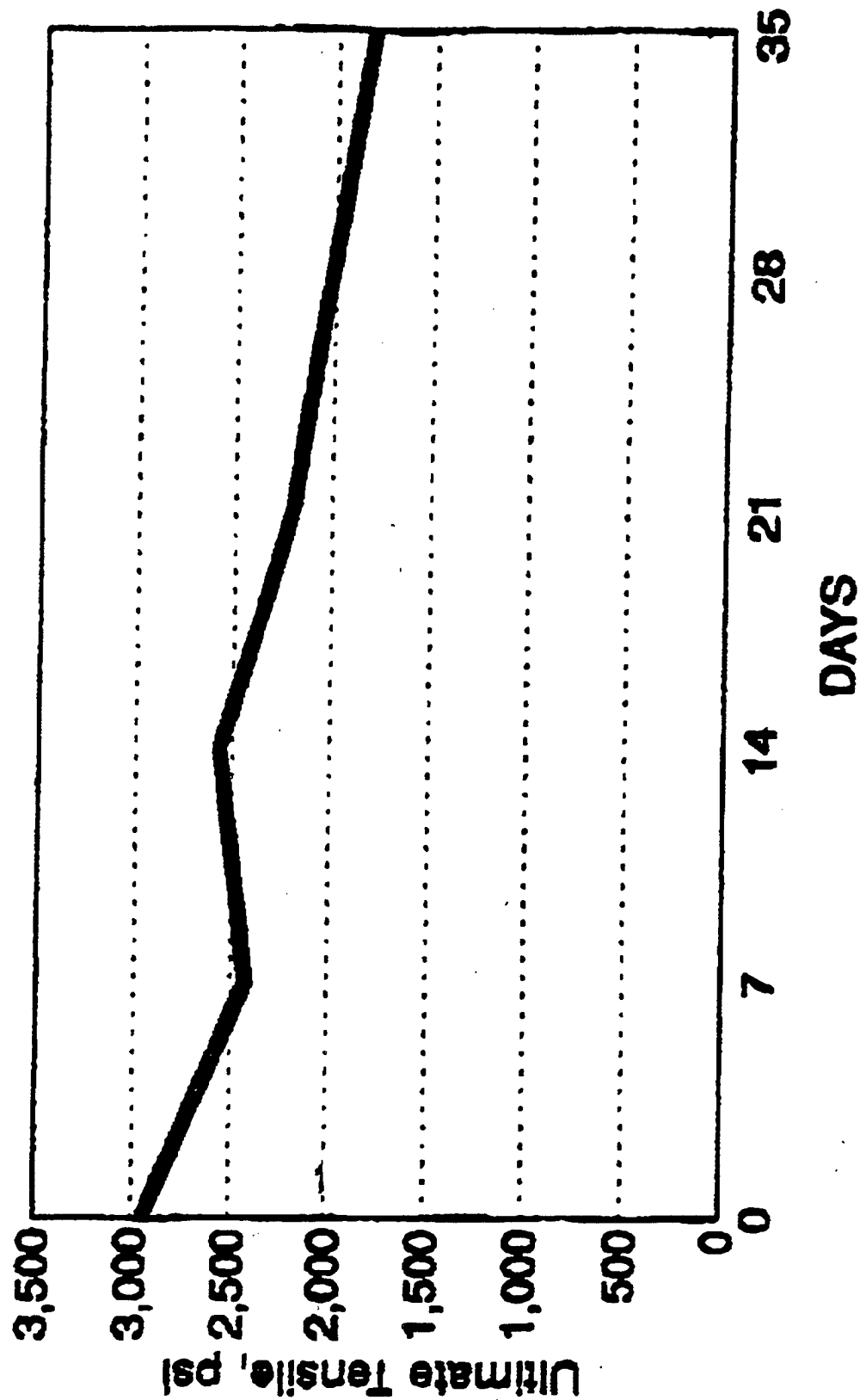
	<u>Originals</u>	
Hardness 'A', pts	64	
Ultimate Tensile, psi	4495	
Ultimate Elongation, %	88	
	<u>C80A-10WN</u>	<u>ASTM Oil #3</u> <u>% Change</u>
Hardness 'A', pts	70	+8
Ultimate Tensile, psi	5510	+23
Ultimate Elongation, %	840	-8
Weight Change, %		-24

- All plaques conditioned for 20 hrs. @ 100° C prior to testing
- Test conditions were 7 day immersion @ 80° C
- All tests were performed in Germany

# C60A-10WN

## HYDROLYTIC STABILITY

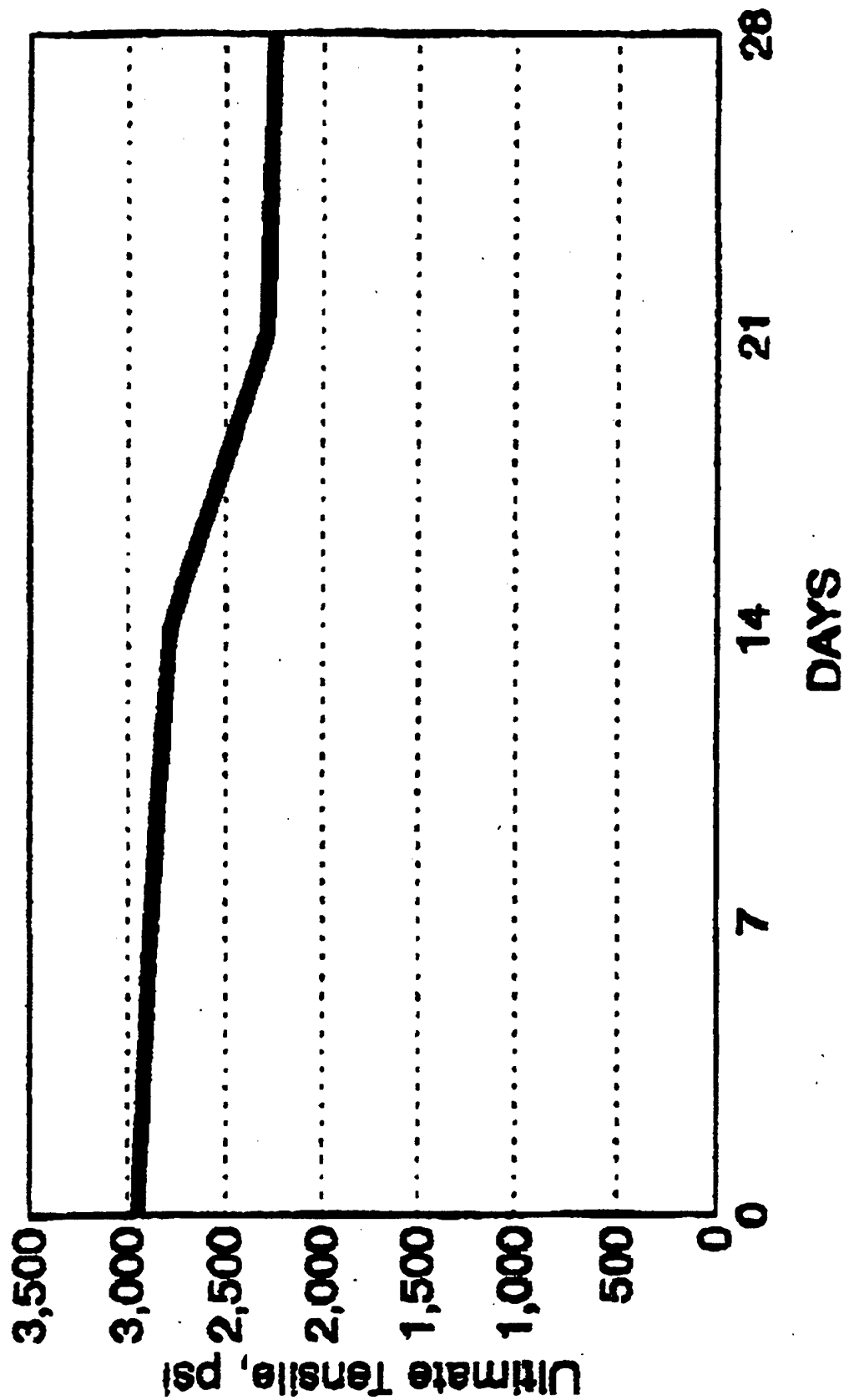
(In Water @ 80 C)



# C60A-10WN

## HYDROLYTIC STABILITY

(Above Water @ 80 C)



**Specification**  
**Gasket, Polyurethane-Ester, Molded, Shape**

1. Scope. This specification is to set forth the minimum requirements for special shaped, molded lengths, of polyurethane-ester, gaskets. There shall be two separate formulations to create both 30A durometer and 40A durometer gaskets. The 30A gasket formulation shall be from now on referred to as gasket "A" and the 40A gasket formulation as "B". All requirements of this specification shall apply to both formulations with the exception of paragraphs 3.5.1 and 3.5.2 and they clearly make the distinction.

2. Applicable Documents

2.1 Government Documents.

AF Drawing No. X9198590

2.2 Non-Government Publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted.

- ASTM D395 - Rubber Property-Compression Set
- ASTM D412 - Rubber Properties in Tension
- ASTM D471 - Rubber Property-Effect of Liquids
- ASTM D573 - Rubber-Deterioration in an Air Oven
- ASTM D624 - Rubber Property-Tear Resistance
- ASTM D792 - Standard Test Methods for Density & Specific Gravity (Relative Density) of Plastics by Displacement
- ASTM D2137 - Rubber Property-Brittleness Point of Flexible Polymers and Coated Fabrics
- ASTM D2240 - Rubber Property-Durometer Hardness
- ASTM D1044 - Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1137).

3. Requirements

3.1 Material. The material shall be polyurethane-ester elastomer formulated and processed to meet the requirements of this specification (see 4.1.1).

3.2 Form. The gaskets shall be in the form of the **molded shape** per Figure 1 (Dwg No X9198590) (see 4.2.1).

3.3 Dimensions and Tolerances. Dimensions shall be accordance with drawing number X9198590, (Figure 1). Tolerances shall be in accordance with Table 1 (see 4.2.1).

3.4 Gasket Length. The gaskets shall be molded in lengths of six (6) feet (see 4.2.1).

3.5 Physical and Mechanical Properties.

3.5.1 Hardness. Measured by Shore-A-Durometer, shall be 30  $\pm$ 5 for gasket "A" and 40  $\pm$ 5 for gasket "B" (see 4.2.2, ASTM D224).

3.5.2 Hardness after Aging. Maximum change in hardness to both gaskets "A" and "B" shall be  $\pm$ 10%. Oven aging process shall be 20 hours at 100°C (212°F) (see 4.2.2, ASTM D224).

3.5.3 Compression Set. The maximum percent of compression set for the aged gaskets shall be 25%. Oven aging process shall be 20 hours at 65°C (150°F) (see 4.2.2, ASTM D395).

3.5.4 Tensile Strength. Minimum tensile strength for unaged gasket material shall be 4.8MPa (700psi). Maximum allowable tensile strength change for aged gasket material shall be -20%. Oven aging process shall be 20 hours at 100°C (212°F) (see 4.2.2, ASTM D412).

3.5.5 Elongation. Minimum percent of elongation is 240%. Maximum percent of change allowable after aging is -40% elongation. Oven aging process shall be 20 hours at 100°C (212°F) (see 4.2.2, ASTM D412).

3.5.6 Tear Resistance. Minimum tear resistance for gasket material shall be 25.0KNm (150ppi) (see 4.2.2, ASTM D624).

3.5.7 Abrasion Resistance. Maximum material loss due to abrasion shall be 10mg (.0001 oz) (see 4.2.2, ASTM D1044).

3.5.8 Brittle Point. Low temperature brittle point minimum is -73°C (-100°F). The specimen shall not fail after single-impact blow, at the temperature specified (see 4.2.2, ASTM D2137).

3.5.9 Volume Change after Water Immersion. Maximum percent of volume change after 70 hours of water immersion at 80°C (176°F) is +5% (see 4.2.2, ASTM D471).

3.5.10 Specific Gravity. Specific gravity after molding shall be equal to the pre-production value  $\pm$ 0.03 (see 4.2.2, ASTM D792).

3.5.11 Color. The color of the gasket shall match the natural color of the compound furnished (see 4.2.1).

3.6 Bonding. The gasket lengths shall have the capability of being bonded together with an adhesive, **the adhesive shall be provided**, to create corner joints. The bonded joint shall withstand/pass a gasket pull test, perpendicular to bond plane, of 20 pounds without signs of separation. The bonding process



shall be chemical in nature (i.e. one or two part epoxy/glue) requiring no mechanical process (i.e. heat welding) (see 4.2.1).

3.6.1 Adhesive. The adhesive shall be provided in small quantity/ single use packaging, one (1) ounce tubes or packets, and shall have a shelf life of two (2) years minimum.

3.7 Packing. Gaskets "A" and "B" shall come packed separately and marked as indicated in 3.7.1. The package shall allow for the gasket lengths to lay straight with out being folded or bent. The packing should be weather resistant to guard against moisture absorption.

3.7.1 Marking. Marking on external package shall identify the durometer, the suppliers name, address, and suppliers part number.

#### 4.0 Quality Assurance Provisions

4.1 Responsibility for Inspection The contractor is responsible for the performance of all inspection requirements (examinations and tests) to ensure the gaskets meet all requirements specified herein. The contractor may use his own or any other facility suitable for the performance of the quality inspection. The Government reserves the right to perform any inspections deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for Compliance All items shall meet all requirements of section 3. The inspections shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirement in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submissions of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Quality Conformance Inspection Quality conformance inspection shall be applied to each item prior to being offered for acceptance under the contract. The gasket shall be examined/tested to determine compliance with all requirements of this specification.

4.2.1 Examination of the End Item The gaskets shall be examined for defects in appearance and workmanship, and defects in dimension.

4.2.2 Testing of the Material. The end item will be tested in accordance with the methods specified in Table II and therefore

shall be the test methods for ensuring the gaskets will meet the requirements herein.

4.3 Acceptance. The gaskets will be accepted if all requirements are met. Requirement verification shall be determined by inspection and testing. The acceptance criteria shall be the tolerances stated in each of the applicable requirements paragraphs (section 3.0) for each appropriate test.

Table I. Dimensional Tolerances.

Size (mm)		Fixed dimension Tolerance (mm) <u>1/</u>	Closure Dimension Tolerance (mm) <u>2/</u>
<u>Above</u>	<u>Incl.</u>		
0	9.99	±0.20	±0.32
10	15.99	0.25	0.40
16	24.99	0.32	0.50
25	39.99	0.40	0.63
40	62.99	0.50	0.80
63	99.99	0.63	1.00
100	159.99	0.80	1.25

160 and over - Multiply by 0.5%

1/ Fixed dimension tolerances apply individually to each fixed dimension by its own size.

2/ Closure dimension tolerances are determined by the largest closure dimension and this single tolerance is used for all other closure dimensions. (Closure dimension refers to any dimension in a place parallel to the plane traced when the mold closes).

Table II. Test Methods for Physical Properties.

<u>Physical Property</u>	<u>ASTM test method</u>
Hardness	D224
Tensile Strength	D412
Elongation	D412
Volume Change	D471
Compression Set	D395
Tear Resistance	D624
Brittle Point	D2137
Oven Aging	D573
Water Immersion	D471
Abrasion Resistance	D1044
Specify Gravity	D792

## APPENDIX B

### GASKET DRAWINGS

#### POLYURETHANE:

1. 9198585
2. 9198590

#### SILICONE:

1. 9198575
2. 9489270
3. 9489271
4. 9489272
5. 9489273

4	3	2	1
REVISEMENTS		DATE	
DESCRIPTION		APPROVED	
LIR			

NOTES:

- INTERPRET DRAWING IAW MIL-STD-100.
- ALL CONVERSIONS FROM METRIC TO ENGLISH UNITS SHALL BE IAW ASTM E380.
- ALL TOLERANCES SHALL BE IAW RMA STANDARD, CLASS A-DWG DESIGNATION A (HIGH PRECISION) FOR GROUP 1 COMPOUNDS.
- IDENTIFICATION OF THE KNOWN SOURCE(S) OF SUPPLY HEREIN IS NOT TO BE CONSTRUED AS A GUARANTEE OF PRESENT OR CONTINUED AVAILABILITY AS A SOURCE OF SUPPLY OR QUALITY OF PRODUCT FOR THE ITEM DESCRIBED ON THE DRAWING.

KNOWN SOURCE OF SUPPLY	
SOURCE	DIE NO.
JAMACK FABRICATION INC. 1401 N. BOWIE DR. WEATHERFORD, TX 76086 (817) 594-8771	2833

SCALE 5/1

QUANTITY REQUIRED PER DASH NO.	SYN	NOMENCLATURE	CAGE CODE	IDENTIFYING NO	MATERIAL/SPECIFICATION	UNIT	VT	ZONE	FIND NO
				-01E					

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES FRACTIONS DECIMALS ANGLES		METRIC	
±.XX ±.3	±.XX ±.3	±.XX ±.3	±.XX ±.3
MATERIAL: POLYURETHANE BASF C60A-10WN		U.S. AIR FORCE	
CURRENT CAGE CODE		P-GASKET	
NEXT ASSEMBLY USED ON		B 0B275 9198585	
APPLICATION		SCALE 1/1	
		SHEET	
		OF	

ENGINEERING DRAWING LAYOUT B

PC - COMPUTER GENERATED



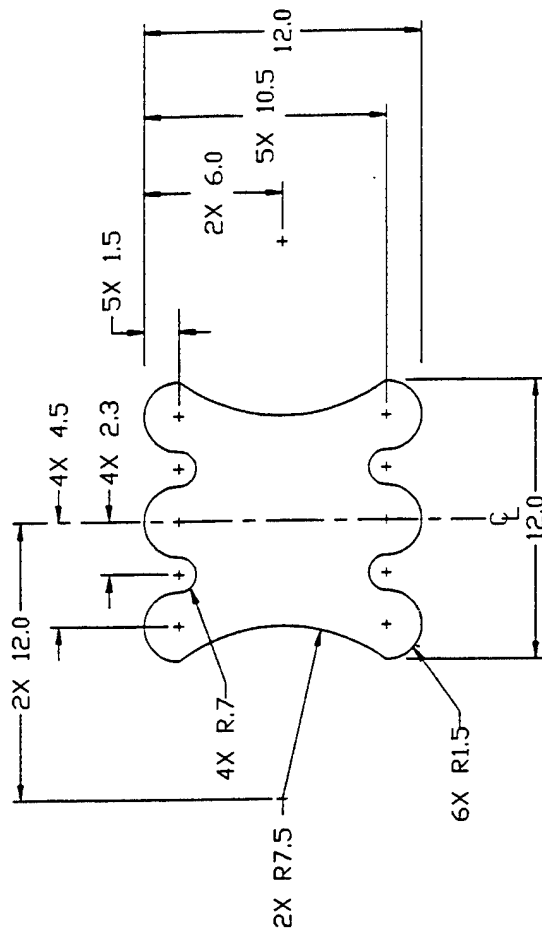


REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

PROTOTYPE 94-07-27

AFPEA PROJ NO. 93-P-125

1. INTERPRET DRAWING IAW MIL-STD-100.
2. ALL CONVERSIONS FROM METRIC TO ENGLISH UNITS SHALL BE IAW ASTM E380.
3. ALL TOLERANCES SHALL BE IAW RMA STANDARD, CLASS 2.
4. IDENTIFICATION OF THE KNOWN SOURCE(S) OF SUPPLY HEREIN IS NOT TO BE CONSTRUED AS A GUARANTEE OF PRESENT OR CONTINUED AVAILABILITY AS A SOURCE OF SUPPLY OR QUALITY OF PRODUCT FOR THE ITEM DESCRIBED ON THE DRAWING.



SCALE 5/1

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[illegible]

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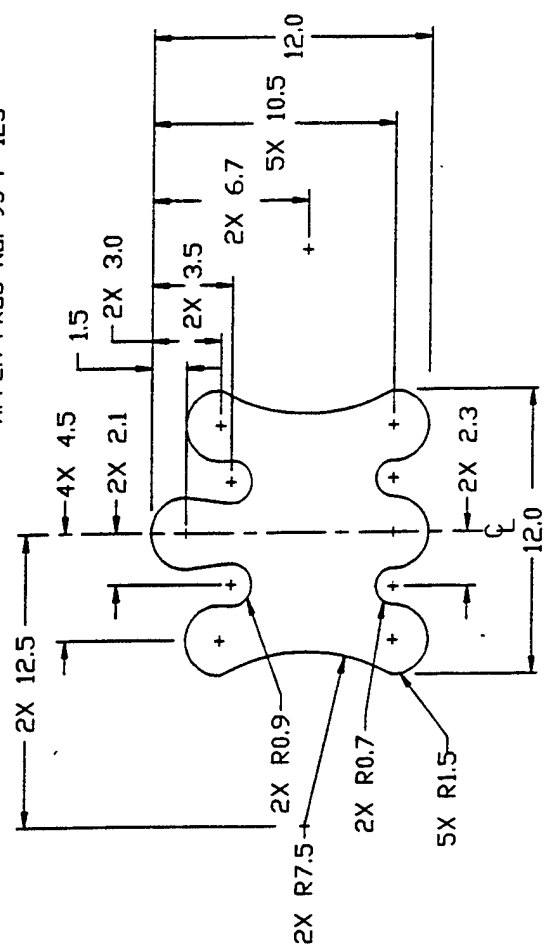
(AUTOCAD, VERSION 12, HQ AFMC/LGTPD)

## ENGINEERING DRAWING LAYOUT B









SCALE 5/1

[illegible]

## **APPENDIX C**

### Test Results

APPROVED FOR PUBLIC RELEASE  
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PROJECT NUMBER: 95-113

SUSAN J. MISRA  
Materials Engineer  
DSN: 787-4519  
Commercial: (513) 257-4519

DEFENSE AMMUNITION PACKAGING COUNCIL  
(DAPC) J7 GASKET TESTING

AFMC LSO/LOP  
5215 THURLOW ST  
WRIGHT-PATTERSON AFB OH 45433-5540

SEP 1995

## **INTRODUCTION**

The objective of this test series was to compare the performance of various gaskets during pneumatic pressure/vacuum retention leaks tests. The outcome of this testing is recommendations for the most reliable gasket(s).

## **CONTAINER DESCRIPTION**

The gasket container is a small-sized, sealed aluminum container (Figures 1 and 2). The container consists of a cover and base. Maximum outer container dimensions are 27.56 inches in length, 27.56 inches in width, and 20.30 inches in depth. The lid is secured by the use of two latches on each side, for a total of four latches. An optional latch on each end is provided to help seal the container, if necessary.

The container was designed and furnished by the requesting branch.

## **GASKET DESCRIPTIONS**

Reference Main Appendix B.

The gaskets were designed and furnished by the requesting branch.

## **TEST PROCEDURE**

The gaskets were tested in accordance with the Air Force Packaging Technology and Engineering Facility (AFPTEF) Container Test Plan, dated 15 Jun 95, (Test Report Appendix B) which referenced FED-STD-101C.

The test methods constitute both the procedure for performing the tests and performance criteria for evaluation of the gaskets. The tests are commonly applied to special shipping containers. The tests were performed at AFMC LSO/LOPM, 5215 Thurlow St, Wright-Patterson AFB, OH 45433-5540.

## TEST SEQUENCES

### TEST SEQUENCE 1 - FED-STD-101C, Method 5009.3, Leaks in Containers.

The following equipment and instrumentation was utilized:

<u>Equipment</u>	<u>Manufacturer</u>	<u>Model</u>	<u>Ser#</u>	<u>Cal Exp</u>
Digital Manometer	Yokogawa	2655-22	85DJ6001	Jun 96
Vacuum/Pressure Pump	Gast Mfg	MOA- P109-AA	0485	N/A

The container pressure relief valve was removed and the relief valve hole used for attachment of the digital manometer and vacuum/pressure pump lines. The empty container was closed and sealed with each gasket. The leak tests were conducted in accordance with FED-STD-101C, Method 5009.3, at ambient and pressure and vacuum.

The pneumatic pressure leak technique (Figure 3) was utilized and the container pressurized to 1.50 pounds per square inch (psig). The maximum allowable leak rate was 0.025 psi/hr (reference Test Report Appendix B, Test Plan).

The vacuum retention leak technique was utilized and the container evacuated to -1.50 psig. The maximum allowable leakage rate was 0.025 psi/hr (reference Test Plan).

Preliminary tests consisted of lubricating one of the gaskets in order to produce a good seal in the gasket area. The container was left overnight and maintained a pressure of 1.5 psig and a leak rate of 0.02 psi/hr. The vacuum retention test maintained a pressure of -1.5 psig and a leak rate of 0.02 psi/hr.

Gasket performance was not affected by the use of the end latches; therefore, only the side latches were used. The side latches were torqued at several levels, in inch-pounds (in.-lb.), in order to determine what the best level was for each gasket, i.e., most gaskets worked best when the latches were torqued to 20 in.-lb. where another gasket worked best when the latches were torqued to 35 in.-lb. The gaskets were removed and rotated after each test to verify performance at each torque level. Because most of the gaskets sealed well when the latches were torqued to 20 in.-lb., this was the level used to perform the comparison tests; however, results are also given for gaskets whose performance improved when latches were torqued at a different level. Once torque level for each gasket was established, a total of five tests each were conducted to compare gasket performances. As in the preliminary tests, gaskets were removed and rotated 90° after each test. The latches were loosened and re-torqued to the required level before each test.

Gaskets exhibited better and more consistent performance during the vacuum retention tests. The noticeable differences in gasket performance occurred during the pneumatic pressure tests. Leak rates and comments for each gasket are as follows, reference Main Appendix B. Results of each test are shown in order to demonstrate the consistencies and inconsistencies. Recommendations are based on the requirements for typical pneumatic pressure/vacuum retention leak tests which state that pressure shall be maintained at 1.50 psig and the leak rate shall not exceed 0.05 psi/hr.

#### **GASKET, DRAWING NUMBER 9198575**

Material: Silicone Rubber, PER ZZ-R-765, Class 2B, Grade 40.

Latches torqued to 20 in.-lb.

#### PNEUMATIC PRESSURE

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate (psi/hr)</u>
1	1.5556	1.5526	0.0030
2	1.5033	1.2960	<b>0.2073</b>
3	1.5466	1.5423	0.0043
4	1.5590	1.4679	<b>0.0911</b>
5	1.5670	1.5561	0.0109

#### COMMENTS:

This gasket performed rather inconsistently. Results appeared to be highly dependent on the placement of the gasket. The gasket was carefully removed and replaced after each test; however, its performance varied greatly without a noticeable difference in its placement in the container. If it was in a position where it performed well, (i.e., a leak rate of no more than 0.05 psi/hr), the lid could be removed and placed back on the container, the latches re-torqued, and it would maintain its excellent performance. However, since one could not determine if the gasket was properly placed until after testing, there is no guarantee that it would perform well each time. Increasing/decreasing the torque level of the latches did not improve its performance.

#### CONCLUSION:

Since the performance of this gasket is not reliable, it is not recommended for use, unless it is verified of sealing the container prior to use and not removed from that position in the container.



VACUUM RETENTION

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate</u> <u>(Absolute Value)</u> <u>(psi/hr)</u>
1	-1.5536	-1.5481	0.0055
2	-1.5357	-1.5343	0.0014
3	-1.5410	-1.4919	0.0491
4	-1.5053	-1.4960	0.0093
5	-1.5276	-1.5211	0.0065

COMMENTS:

The gasket exceeded the requirements of the vacuum retention test with the greatest leak rate being 0.0491 psi/hr.

**GASKET1, DRAWING NUMBER X9489270**

Material: Silicone Rubber, PER ZZ-R-765, Class 2B, Grade 40.

Latches torqued to 20 in.-lb.

PNEUMATIC PRESSURE

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate</u> <u>(psi/hr)</u>
1	1.5516	1.5419	0.0097
2	1.5448	1.4940	<b>0.0508</b>
3	1.5493	1.5154	0.0339
4	1.5258	1.4930	0.0328
5	1.5423	1.4921	0.0502

COMMENTS:

This gasket performed fairly consistently and usually exceeded pressure test requirements.

VACUUM RETENTION

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate</u> <u>(Absolute Value)</u> <u>(psi/hr)</u>
1	-1.5480	-1.5506	0.0026
2	-1.5429	-1.5230	0.0268
3	-1.5516	-1.5424	0.0051
4	-1.5478	-1.5475	0.0003
5	-1.5527	-1.5392	0.0135

COMMENTS:

The gasket exceeded the requirements of the vacuum retention test with the greatest leak rate being 0.0268 psi/hr.

**GASKET2, DRAWING NUMBER X9489271**

Material: Silicone Rubber, PER ZZ-R-765, Class 2B, Grade 40.

Latches torqued to 35 in.-lb.

PNEUMATIC PRESSURE

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate (psi/hr)</u>
1	1.5455	1.5321	0.0224
2	1.5512	1.4666	<b>0.0846</b>
3	1.5418	1.5297	0.0121
4	1.5442	1.5207	0.0235
5	1.5393	1.5238	0.0155

COMMENTS:

This gasket performed fairly consistently; however, it would not hold a seal when the latches were torqued at 20 in.-lb. All of the other silicone rubber gaskets sealed extremely well when the latches were torqued at 20 in.-lb. Because the latches needed to be torqued so high (35 in.-lb.) it made securing the lid quite difficult.

CONCLUSION:

This gasket is not recommended as other gaskets had better performance and it is much easier to secure the lid with the latches being torqued at a lower level.

VACUUM RETENTION

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate (Absolute Value) (psi/hr)</u>
1	-1.5478	-1.5184	0.0294
2	-1.5476	-1.5272	0.0204
3	-1.5376	-1.4831	<b>0.0545</b>
4	-1.5518	-1.5410	0.0108
5	-1.5499	-1.5462	0.0037

COMMENTS:

The gasket usually met the requirements of the vacuum retention test with the greatest leak rate being 0.0545 psi/hr.

**GASKET3, DRAWING NUMBER X9489272**

Material: Silicone Rubber, PER ZZ-R-765, Class 2B, Grade 40.

Latches torqued to 20 in.-lb.

PNEUMATIC PRESSURE

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate (psi/hr)</u>
1	1.5629	1.5582	0.0047
2	1.5441	1.5252	0.0189
3	1.5545	1.5372	0.0173
4	1.5535	1.5350	0.0185
5	1.5492	1.5432	0.0060

COMMENTS:

This gasket had the best performance of all. In fact, it had excellent performance as the greatest leak rate encountered was only 0.0189 psi/hr which is significantly below the normally accepted value. Its performance is extremely consistent and is quite reliable.

VACUUM RETENTION

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate (Absolute Value) (psi/hr)</u>
1	-1.5462	-1.5365	0.0097
2	-1.5550	-1.5539	0.0011
3	-1.5378	-1.5301	0.0077
4	-1.5428	-1.5273	0.0155
5	-1.5476	-1.5315	0.0161

COMMENTS:

The gasket exceeded the requirements of the vacuum retention test with the greatest leak rate being 0.0161 psi/hr.

**GASKET4, DRAWING NUMBER X9489273**

Material: Silicone Rubber, PER ZZ-R-765, Class 2B, Grade 40.

Latches torqued to 20 in.-lb.

PNEUMATIC PRESSURE

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate (psi/hr)</u>
1	1.5571	1.5543	0.0028
2	1.5555	1.5254	0.0301
3	1.5245	1.5005	0.0240
4	1.5310	1.4990	0.0320
5	1.5609	1.5355	0.0254

COMMENTS:

This gasket had consistent, excellent performance as its greatest leak rate was only 0.0320 psi/hr.

VACUUM RETENTION

<u>Test #</u>	<u>Initial psig</u>	<u>Final psig</u>	<u>Leak Rate (Absolute Value) (psi/hr)</u>
1	-1.5458	-1.5313	0.0145
2	-1.5417	-1.5251	0.0166
3	-1.5275	-1.5161	0.0114
4	-1.4933	-1.4829	0.0104
5	-1.5497	-1.5487	0.0010

COMMENTS:

The gasket exceeded the requirements of the vacuum retention test with the greatest leak rate being 0.0166 psi/hr.

**X-GASKET, DRAWING NUMBER X9489276, DUROMETER 30**

Material: Polyurethane.

**COMMENTS:**

This gasket did not seal during either test. Its performance was not affected by increasing or decreasing the torque of the latches. All tests were terminated when the pressure decreased/increased to 1.36 psig/-1.36 psig. This decrease/increase in pressure occurred, on an average, only ten minutes into the test. During the pneumatic pressure test, the sound of air escaping from the corners of the container was audible from about twenty-four inches away from the leak.

**X-GASKET, DRAWING NUMBER X9489276, DUROMETER 40**

Material: Polyurethane.

**COMMENTS:**

This gasket did not seal during either test. Its performance was not affected by increasing or decreasing the torque of the latches. The pressure decreased/increased to about 1.0 psig/-1.0 psig, on an average, less than five minutes into the test. During the pneumatic pressure test, the sound of air escaping from the corners of the container was audible from about twenty-four inches away from the leak.

**CONCLUSIONS AND RECOMMENDATIONS**

One important factor in the performance of the gaskets was their placement in the container. Preliminary tests concluded that the corners needed to be evenly squared before securing the lid. This usually needed to be accomplished after the gasket was placed within the channel of the container.

The polyurethane gaskets would not seal the container. The material itself tended to stick together in the shipping carton. As each strip of the material was removed from the carton, it generally needed to be peeled away from the other strips, causing gouges in the strips of material. In addition, the corners of the gaskets were not evenly sealed and apparently the standard sealing methods of the other gaskets could not be used.

The overall recommendation is the use of gasket 3, drawing number X9489272, as it performed with the most reliability and the lowest leak rates. Even though comparison tests were conducted with the latches torqued at 20 in.-lb., this gasket still exhibited an average leak rate of only 0.0294 psi/hr when the tension of the latches was torqued at only 17 in.-lb.; therefore, easing the use of the latches.

APPENDIX A  
PHOTOGRAPHS

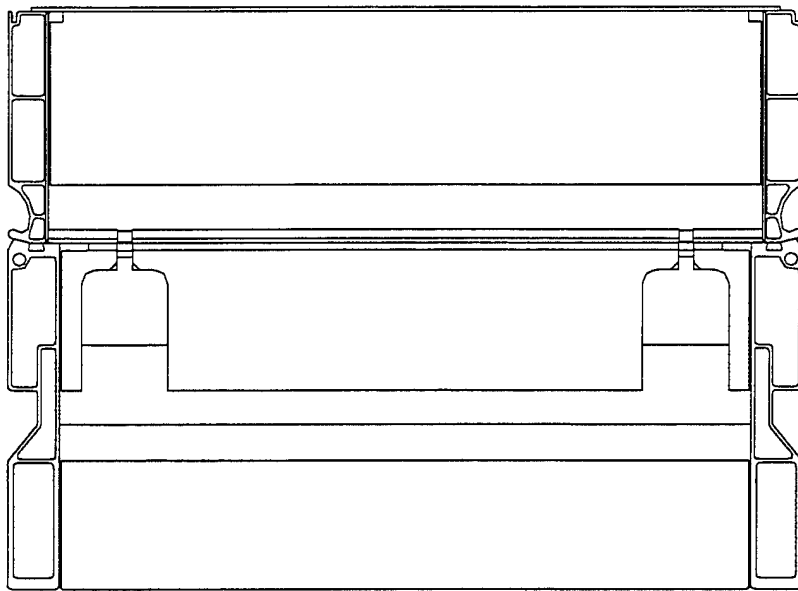


Figure 1. Container Drawing.

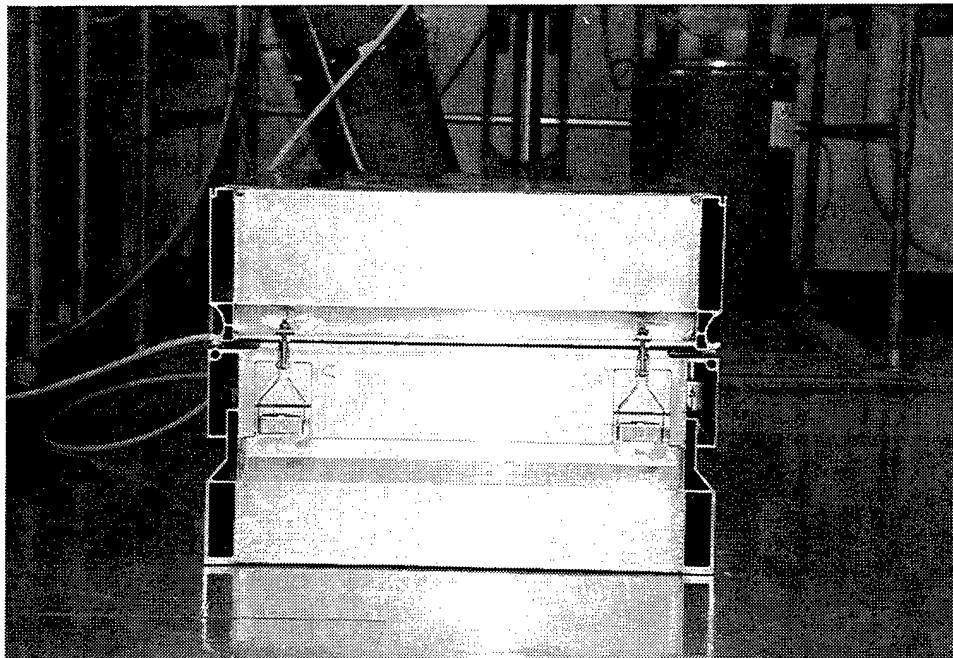


Figure 2. Container.

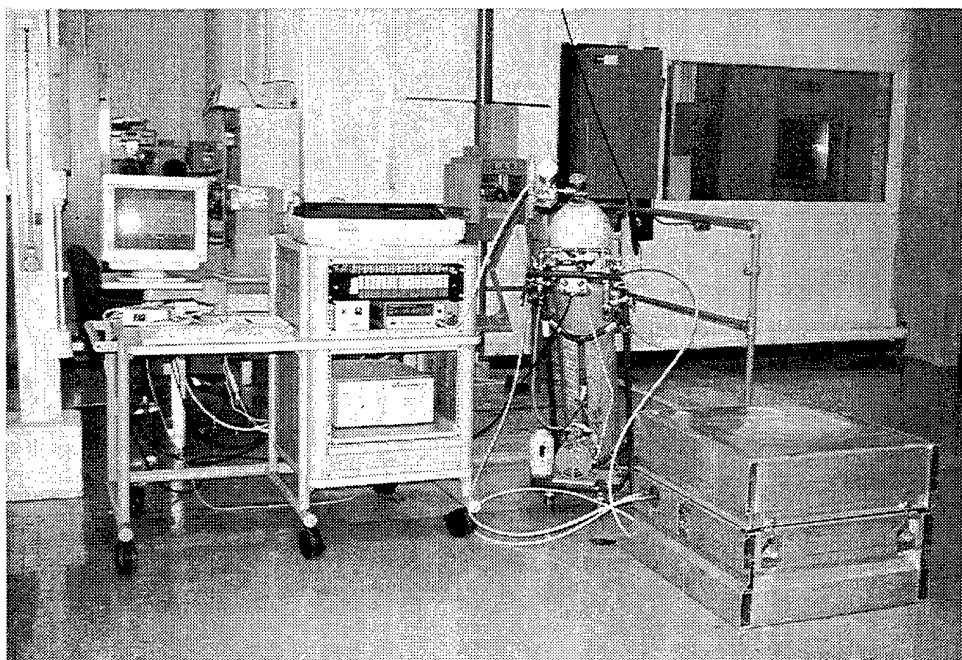


Figure 3. Pneumatic Pressure/Vacuum Retention Leak Test.



APPENDIX B  
TEST PLAN

<b>AIR FORCE PACKAGING TECHNOLOGY &amp; ENGINEERING FACILITY (Container Test Plan)</b>				AFPTEF PROJECT NUMBER: 93-P-125	
CONTAINER SIZE (L x W x D) (MILLIMETERS) INTERIOR: 610 X 610 X393		EXTERIOR: 700 X700 X515		WEIGHT (Kgs) GROSS: 45	ITEM:
CUBE (CU. M)				QUANTITY: 1	DATE: 15 Jun 95
ITEM NAME: GASKETS SHAPES AND MATERIALS				MANUFACTURER:	
CONTAINER NAME: DAPC J7 GASKET TEST CONTAINER				CONTAINER COST:	
PACK DESCRIPTION:					
CONDITIONING: AMBIENT					
TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION	
1.	<u>LEAK TEST (Container)</u>				
a.	FTMS 101 MTHD 5009.3	Pneumatic Pressure at 1.50 PSIG, allow for temperature/pressure stabilization. Test duration after stabilation shall be 60 minutes. Leak rate shall be measured during the test period. Leak Rate shall not exceed 0.025 PSI in 60 minutes.	Ambient temp. Pressurize and evacuate with compressed air supply/vacuum pump.	Digital Manometer (DM) Data Acq. Sys (DAS)	
b.	FTMS 101 MTHD 5009.3	Vacuum Retention at 1.50 PSIG, allow for temperature/pressure stabilization. Test duration after stabilation shall be 60 minutes. Leak rate shall be measured during the test period. Leak Rate shall not exceed 0.025 PSIG in 60 minutes.	Ambient temp.	DM DAS	
2.	<u>LEAK TEST (For each Gasket Configuration)</u>				
a.	FTMS 101 MTHD 5009.3	Pneumatic Pressure at 1.50 PSIG, allow for temperature/pressure stabilization. Test duration after stabilation shall be 60 minutes. Leak rate shall be measured and recorded during the entire test period.	Ambient temp. Pressurize and evacuate with compressed air supply/vacuum pump.	DM DAS	
b.	FTMS 101 MTHD 5009.3	Vacuum Retention at 1.50 PSIG, allow for temperature/pressure stabilization. Test duration after stabilation shall be 60 minutes. Leak rate shall be measured and recorded during the entire test period.	Ambient temp.	DM DAS	
COMMENTS: Temperature and Pressure Graphs required. All latches shall apply even pressure to create a sealed container, lock tight to disallow readjustment.					
PREPARED BY: RobbinMiller, Mechanical Engineer			APPROVED BY: Ted Hinds, Chief, Design Group, AFPTEA		

## **APPENDIX D**

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# DISTRIBUTION LIST

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CRANE, IN 47522

## **APPENDIX E**

### **REPORT DOCUMENTATION**

# REPORT DOCUMENTATION PAGE

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1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 2 August 1996		3. REPORT TYPE AND DATES COVERED Final Oct 93 - Jul 96	
4. TITLE AND SUBTITLE RESEARCH GASKET SHAPES AND MATERIALS FOR SEALED AMMUNITION CONTAINERS					
5. AUTHOR(S) ROBBIN L. MILLER MECHANICAL ENGINEER					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AFMC LSO/LOP 5215 THURLOW ST WRIGHT-PATTERSON AFB OH 45433-5540				96-R-05	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)					
11. SUPPLEMENTARY NOTES					
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13. ABSTRACT (Maximum 200 words) The objective of this project was to investigate new materials and shapes available for use as gaskets in sealed containers. The properties of the new materials had to be evaluated/tested to assure they met or exceeded the properties of current gasket materials. The project also looked at the manufacturing processes of extruding vs. molding. We also investigated the joint bonding process of using chemical adhesive as well as vulcanizing and heat welding. Another aspect of the project was to evaluate the required cross sectional area and hence the compression required to create a sealed container repeatedly with the minimum amount of force.					
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